Macerone, Francis
Hints to paviors, 1833.

HINTS TO PAVIORS,

BY

FRANCIS MACERONE:

AN INTRODUCTORY REVIEW,

By J. C. ROBERTSON, Esq. *Editor of the Mechanics' Magazine,*

OF

THE VARIOUS PLANS PROPOSED FOR THE IMPROVEMENT OF CARRIAGE PAVEMENTS:

ALSO,

A PAPER ON THE INCREASING OF DAY-LIGHT IN LONDON,

&c.

Second Edition.

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INTRODUCTORY REVIEW,

By. J. C. ROBERTSON, Esq.

The defective condition of the carriage-ways of the British metropolis, and of almost all the cities and towns of England, forms a singular exception to that high state of improvement which the public works of this country generally exhibit. It is an evil which every one observes, and feels, and complains of, and which has, nevertheless, subsisted for a long series of years without any serious or rational attempt being made to have it remedied. Travelling has made wondrous strides in point of ease and expedition, and this has necessarily been the consequence of much improvement in every thing on which quick and comfortable travelling depends—of improved roads, improved carriages, improved driving, &c. But, as regards the roads, it is those of the *country* alone which have partaken of this improvement; for still, at every town you enter, you find things nearly as they were fifty years ago; the causeways as rugged, rutty, and merciless to flesh and bones, as they were in the days of our grandsires.

Mr. M'Adam, who has done so much, by the system to which he has given his name, to improve the country roads of England, has been recently employed to re-lay some of the streets of the metropolis on the same plan; and every thing that could conduce to give the experiment a fair trial—money, time, and facilities of all sorts—have been placed at his command. The experiment, however, may be regarded as a complete failure. The utmost that Macadamization can be said to have effected any where in

London, is some gain in point of smoothness, and a diminution of the noise occasioned by the passage of carriages and waggons —benefits that compensate but poorly for the many serious evils with which it is attended. In all the great thoroughfares that have been re-laid on Mr. M'Adam's system, such as Westminster and Blackfriars' Bridges, Oxford, Bishopsgate*, and Coleman Streets, where the traffic is busy and incessant—where carriages of all descriptions are constantly passing to and fro, and in the most zig-zag directions—the *metal*, as it is called, is so rapidly ground to dust, that it is only by a constant supply, at a great expense, of new materials, that the carriage-ways are kept in a passable state; and in all weathers, whether wet or dry, the produce of this perpetual grinding process, is alike annoying and injurious to the inhabitants and to passengers. At one time you have to wade your way through pools of mud, at another to buffet it amidst clouds and whirlwinds of dust; clothes, houses (inside and out), furniture, health, and comfort, are all alike sufferers by the nuisance. Every passing creature and thing serves as it were the office of a mud or dust-cart, and every adjacent building as a resting place for the flying favours of Macadamization. Nor does the evil stop here; for, after all the mud and dust thus carried off, there still remains an abundant residue, which finds its way into the public sewers, supplying them with a sort of food which must ere long (should the system not be abandoned) produce obstructions most injurious to the bodily constitution of this great metropolis, and which can only be removed at great inconvenience and expense.

Streets constantly in want of repair, always mending and never mended—a great increase of expenditure (amounting in some cases, as the writer has been assured, to triple and quadruple that incurred under the old system); inundations of mud in winter and clouds of dust in summer; persons and property injured; the very *primæ viæ* of the city obstructed;—such are the evil consequences of a system, which offers in return only a little less noise, and a little more ease to those who ride.

All these evils are of course proportionably diminished, according as the traffic is more or less frequent. Nor is it meant

* The Macadamization of Bishopsgate Street alone is said to have occasioned an expense of about £.1,500 for clearing the sewers!

to be denied, that in many retired streets and squares Mr. M'Adam's system has been and may be adopted with counterbalancing advantages. Wherever, in fact, the traffic is not greater than on most country roads, Macadamization will be found equally beneficial—with this difference only, that the number of persons liable to be annoyed by the vicinity of a dusty or muddy road is greater in town than in the country.

That a system which suits the country well should fail so completely in town, is only what might have been naturally expected from the great difference between the two. Why were causeways of hard granite ever thought of for towns at all? And why have the blocks of these causeways been made, from time to time, larger and larger? Because, doubtless, of the greater traffic in town than in the country, and of the insufficiency of streets constructed of smaller and less durable materials to withstand the tear and wear which that traffic occasions. What, then, is this attempt to extend the system of Mr. M'Adam into the hearts of our cities, but a recurrence to that very state of things, which general experience long ago pronounced to be intolerable?

The very fact, that Mr. M'Adam's system is pretended to be equally good for town and country, ought of itself to be decisive of the fallacy of that pretension. It is *impossible* that any system whatever could produce the same results, under circumstances so diametrically opposite.

The only other plan for improving the streets of the metropolis which the writer has seen reduced to the test of experiment is, that for which Mr. Richard Macnamara has taken out a patent. The "*identifying*" feature of this invention is stated to be, that "it consists in working, cutting, or forming the sides of blocks or stones, so that they shall make alternately obtuse and acute angles, with the upper surface of the block, or stone; which being done, they may be so arranged, or combined, *that they will mutually, and reciprocally, support and preserve each other from the imperfections* so generally found in the usual mode of paving." In other words, Mr. Macnamara proposes to cover each carriage-way with a sort of straight arch of regular masonry, consisting of stones so fashioned and combined, that they shall mechanically keep each other from sinking, and present, at all times, a level surface, or nearly so. And to prove the practicability of such a system of paving, the patentee refers to a

specimen to be seen in Guildford Street, Brunswick Square, "where it has been down five years without any reparation."

The Writer has inspected that specimen; but to him it furnishes any thing but a proof of the efficacy of Mr. MACNAMARA's plan of improvement. The stones, so far from exhibiting an uniform surface, produced by that mutual support and dependance, that equality of action and re-action, which Mr. MACNAMARA states to be the identifying principle of his invention, have settled into a state of as great irregularity as any part of the adjoining pavement on the old plan; some have sunk very much, and there is scarcely one but has fallen away from those adjoining it.

Nor would this have been a fair specimen, had it been even better than it is. Only about *half* of the carriage-way referred to—namely, that near the houses, is paved on Mr. MACNAMARA's plan. Now, every one knows, that it is on the centre, or crown, of a causeway that the traffic is always greatest, and from the effects produced *there*, that an opinion may best be formed of the efficiency of any system of paving.

Nothing else, however, could possibly result from the attempt to exemplify such a principle as that of Mr. MACNAMARA's patent. It is palpably a most erroneous principle. Stones shaped and arranged in the manner prescribed by him, will *not* mechanically hang together under a superincumbent pressure (which is what his patent asserts); not at least without a number of adjunctive helps, of which he seems to take no account, and scarcely even with these. It is on the authority of the patentee himself that we have likened his plan of paving to that of a straight arch; but he ought to have added—to an arch *without piers, abutments, or foundation of any sort.* When we further consider, how expensive such an adamantine and nicely-constructed pavement must be (a point on which the patentee has been wholly silent), and that were it adopted throughout the metropolis, the whole of the old paving, laid down at a vast expense, must go for little or nothing, there can be no hazard in pronouncing Mr. MACNAMARA's scheme as inexpedient as it is inefficient.

A writer in the Mechanics' Magazine (Vol. II. p. 216, June 12, 1824), has proposed, as subsidiary to "an improved line of subways," that the ordinary paving should have an "underlayer of large unhewn stone, well bedded in earth;" and this suggestion he enforces with a remark particularly worthy of attention.

" It is a matter," he says " of no surprise that the paving stones sink into hollows, without the aid of other causes than the looseness of the earth on which they are laid; it generally consists of broken bricks, the refuse from cinder hills, and uncementing rubbish of all descriptions; *the surprise is*, that no *means have yet been adopted to reach the root of the evil, by producing a better bedding surface for the superincumbent paving.*"

There can be no doubt of the efficacy of such a substratum as is here proposed; but to say nothing of its costliness, there is one obstacle to its adoption that will probably never be obviated. " An underlayer of large unhewn stone" could not be easily lifted, and it would be requisite (as the proposer admits) that such an improved system of subways should be previously substituted, as would supersede the necessity, which now so frequently exists, of breaking up the pavement, for the purpose of laying and repairing sewers, water and gas pipes, &c.; an alteration of too entire and costly a description to be looked for in an old metropolis like London; which, even as matters are, may boast of excelling all other cities in the management of its sewers*.

A plan of paving, somewhat different from any yet mentioned, is to be found in the London Journal of Science for March 1825. The author, a Mr. JOHN FINLAYSON, submits it as particularly " suited to the streets of London, and other great towns." He proposes, first of all (agreeing as to the principal defect with the author of the preceding plan), that " the bed, or foundation, of the road should be prepared by rolling, ramming, or otherwise, so as to be perfectly solid, and as level as possible; that on this foundation there should be laid a series of iron boxes of an oblong shape, about 4½ feet long and 2½ broad, each containing eighteen square sockets, and each of these sockets a wooden block (as a substitute for granite) with the grain upwards; and that, in order to wedge and confine the blocks firmly, and prevent them from being shook, or displaced, gravel, broken stones, or hard rubbish, should be rammed in between them." A road, thus formed, he says, would be so firm and compact, " that neither time, nor the

* *(Note to Second Edition.)* A most silly and unavailing work of supererogation! Surely this is only putting one pavement over another!

heaviest weights which might pass over it, would in any degree alter its level, or destroy the materials of which it is composed."

In explanation of the substitution of wood for granite (the most novel and startling feature of this scheme), Mr. FINLAYSON states, that he has found, by experience, that there is much less waste of wood, set on end in the manner above described, than in the case of the hardest whin, or granite, when exposed to the same wear. "I made the experiment," he says, "many years ago, on a pavement upon my father's premises. Our stones frequently sunk, and, for experiment, I cut some pieces of wood according to the size required, and introduced them in place of the stone, set on end in the same manner I have already described, with wood planks at the bottom; and, after *a lapse of twenty-five years*, I observe that the granite has undergone more wear than the wood, the latter of which now stands more prominent and flush than any other part of the causeway that surrounds it. I raised some of the wooden blocks, expecting them to have undergone considerable decay, but was surprised, on finding that the wood was quite as fresh as on the day it was laid."

Better evidence than this of the superiority of wood over stone for highways could scarcely be desired, nor is it difficult to perceive whence this difficulty arises. A hard, yet fibrous substance *yields* only, while one that is much harder, but friable, is at once broken and dispersed.

The advantages, then, which Mr. FINLAYSON claims for his plan, are chiefly these:—

1*st*. That there would be "less waste" of material, and, of course, "less mud or dirt in wet weather, and less dust in dry."

2*nd*. "That the noise of the passing carriages would be entirely deadened," or comparatively so.

3*rd*. That the wear and tear of horses and carriages would be greatly diminished.

And 4*th*. That "should any portion of the pavement require to be raised at any time, to get to the water or gas pipes, it could be laid down precisely in the same manner as it was taken up."

The projector of this improvement seems not to have been aware, that it is one, which, in its principal feature, has already had the sanction of considerable experience in its favour; for though it is new to Britain, it is not so to other countries. In

Vienna*, Munich, and other continental capitals, the large open courts of the principal residences are all paved with blocks of hard wood, set on edge, over which carriages roll almost without noise.

Mr. FINLAYSON proposes the addition of cast-iron cellular boxes to hold these blocks of wood; and herein we shall perhaps find that his plan is rather an alteration than improvement of the continental practice. The most obvious effect of these iron divisions and sub-divisions would be to separate, as much as possible, the component parts of the pavement, the blocks, from each other, and the whole from their natural bed, or foundation; whereas, it should seem that the true way to produce a stable and uniform pavement, is to combine the various parts as closely as possible, to make each block depend upon its neighbour, and to give the whole a firm hold of the soil on which they rest. Blocks thus connected, would, like false teeth, be easily shaken loose; and if they rose or sunk, it would, in consequence of their being packed in these divisional boxes, be only in companies of eighteen at a time. The hollows and prominences of a carriage-way so constructed (and such inequalities would occasionally occur under the best system of superintendence) would all be on the grand scale of four feet and a half by two and a half. The

* *Note to Second Edition.*—It is the practice in Vienna and some other cities to pave the open courts of the hotels with blocks of hard wood, a few inches long, set on edge, over which wheel-carriages roll almost without noise. We think a hint might be taken from this practice for paving our suspension bridges. A stratum of road metal (broken stone), four or five inches thick, laid upon one of these bridges, will nearly double its weight, and render much additional strength and cost necessary. Were strong blocks of hard wood substituted for the stone, *two-thirds* of the weight would be saved, and also two-thirds of the additional expense which a stone-road would occasion. Were the pores or tubular cavities of the wood previously filled with a calcareous or other stony solution, or even with pitch, its hardness would be a good deal increased, and its durability still more, by the exclusion of the water. As broken wood would answer for this purpose, and as the labour of cutting and laying would be comparatively small, we do not think the expense would much exceed that of M'Adam's road metal. We have often wondered, indeed, that the Vienna wooden pavement is not adopted in some of our most fashionable streets, where the noise occasioned by the constant passing of coaches must be felt as a serious nuisance. Were the paving of each street under the management of the proprietors, we have little doubt that improvements of this and other descriptions would be introduced.—*Edinburgh Review.*

noise, too, must necessarily be much greater with the iron cases than without them.

Mr. FINLAYSON reckons it, indeed, among the advantages of his plan, that this packing of the blocks into separate cases, would make it easier to relay any portion of the pavement, when raised to get to the water or gas pipes, *precisely as it was before;* but it is an advantage, the reality of which may be fairly doubted. After the bed or foundation has been once made as perfectly solid and level as Mr. FINLAYSON recommends, there can apparently be as little difficulty in restoring blocks to their previous situation when taken up one by one, as when removed in cases of eighteen. The fewer blocks, too, lifted at any time the better; economy, convenience, and dispatch, will all alike be consulted, by so constructing the pavement that you may always lift just as much as is absolutely necessary, and no more.

In every view, then, that can be taken of these iron accompaniments of Mr. FINLAYSON's plan, they promise nothing but disadvantages; a loose pavement, more noise, more trouble, and more expense. The plan has still, however, some valuable circumstances to recommend it,—its "solid foundation," its wooden blocks, and its having been actually practised with success. That an efficient and durable carriage-way might be made of wood, seems at least abundantly probable.

Mr. FINLAYSON offers no estimate of the expense of laying down such a pavement; but should it invite adoption, in other respects, it is not likely that the cost of it would furnish an objection of much weight. It could scarcely be more expensive than Mr. M'ADAM's plan, adopted with so little hesitation, which destroys every thing and leaves matters precisely where they were before streets were paved at all. The probability is, that a wooden pavement (without the iron accompaniments) would not be dearer than one of stone; but were it even twice or thrice as costly as the ordinary paving, any such additional expense would be amply repaid, should the greater uniformity, cleanliness, quiet, and durability which it promises, be realized.

In the new streets particularly, which are every day branching out from this great aggregation of cities, it seems desirable that a trial of this sort of pavement should be made; in those more especially towards the west and north, where fashion and luxury seem destined to fix their abodes, and where superior quiet must

of course have its highest value, there no old pavement would have to be thrown aside, and its value lost to the community; the new plan would be encumbered with those expenses only which legitimately belong to it.

All the plans, it will be observed, hitherto noticed, are of the nature of *entire substitutions* for the present defective paving, that of the writer in the Mechanics' Magazine alone excepted, who merely proposes to substitute a better substratum. But we have now to request attention to a scheme which takes a middle, and perhaps, on the whole, a safer course, than any of these; a scheme which has for its object merely to remedy the defects of things as they are, and which is such, that it may be applied to any sort of pavement, *whether of stone, wood, or any other material.* It is contained in a small pamphlet, by Colonel MACERONE, entitled "Hints to Paviors," printed in 1825, for private distribution, and now, with the author's permission, annexed to these remarks.

Colonel M. commences his pamphlet with an account of the different sorts of pavement adopted in Rome (ancient and modern), Naples, Florence, Sienna, Milan, and other Italian cities. He shows, that though these have been no where excelled in point of durability, yet that they are only suited to their respective localities, and none of them calculated to be applied with advantage to the streets of such a city as London. He then touches on the plans of Mr. M'ADAM and Mr. MACNAMARA, but with a degree of reserve as to their demerits, dictated apparently by a sense of delicacy towards projects to which his own must be considered as a rival. Of Mr. FINLAYSON'S he says nothing, not being aware, it is presumed, of its existence*. The plan which he finally submits, may be considered under three heads:—

First, Col. M. proposes that "the ground previously to laying the stones" should be well hardened. Mr. FINLAYSON, as we have seen, also begins with "rolling and ramming the bed or foundation," so as to make it perfectly solid and level; nor can there be any doubt that it is to the want of such a foundation, that the defects in the existing system of paving are chiefly to be

* *Note to the Second Edition.*—He was well aware of its existence, and also of its excellence; but a main feature in his plan is, the making a good and permanent road with the stones and materials already in use, *and without any extra expense.*

ascribed. Nothing, indeed, can well be imagined more *necessarily* inefficient than the substratum of loose earth and rubbish, in which the London Paviors have so long delighted, with so much advantage to themselves, and loss to the community. No good pavement could ever be constructed on so trashy a foundation.

Colonel M. recommends for the substratum, " a mixture of broken gravel, dry rubbish, and a little chalk," and hints that their agglomeration would be much promoted by the addition of any animal or oleaginous fluid, such as " the blood of all cattle, and the broth from the huge cauldrons at Whitechapel, wherein many horses are boiled at a time, for dogs'-meat." On the advantages of the latter, Colonel M. does not perhaps sufficiently insist; he seems to put his chief trust in mere *mechanical* induration. The examples in nature are numerous, of animal gelatinous matter forming, in combination with aluminous and calcareous earths and silicious sands, substances so hard and compact, as even to strike fire with steel. Any sort of fatty liquid would serve for the purpose, and none better than that which the dogs'-meat men of Whitechapel can supply in abundance.

Coal tar would have nearly a similar effect, and may still be obtained at so cheap a rate from the gas-works, as to maintain a competition with the produce of the Whitechapel cauldrons, that would keep down the price of both. " About a year ago," says the Colonel, in a letter to the Mechanics' Magazine (p. 365, vol. 6), " I poured a quantity of coal tar upon a heap of road-scrapings, which, when removed six months after, was much harder than a mass of solid chalk. A walk made of gravel and road-scrapings, to which I also applied coal tar, became as hard as a rock." Another correspondent of the same work states (p. 270, vol. 2), that " Margate Pier has been done in this way; and though it is several years since the tar was put on, it remains as firm as it was at first."

The only objection that could be offered to this hardening of the foundation is, that it will make it more difficult to break it up (at present nothing is so easy) when access is wanted to the subjacent sewers, and water and gas pipes. Undoubtedly it will do so; but can there be any hesitation in choosing between a little more labour *occasionally*, and bad roads, that are of every-day use, *perpetually?* No person, of course, will suppose that it is meant,

that the hardening process should be carried so far, as actually to make the substratum "as hard as a rock;" all that is intended by pointing out the indurating qualities of animal liquids and mineral tar, is to show that they may be made materially subservient to the general purpose of binding the materials of the substratum firmly together, as long as circumstances will allow; circumstances of such daily occurrence, that no induration can ever take place to such a degree as to require more than a little extra exertion of those pickaxes which every opening of a pavement now calls into requisition; *and by the powerful mechanical means devised by Colonel M.* ANY PART *of the pavement which has been taken up, can be immediately restored to the hardness and solidity of the rest.*

Colonel M. proposes, *secondly*, "to fix and depress the stones when laid;" that is, to combine the superstructure with the substratum, in the manner which, in treating of Mr. FINLAYSON's plan, it has been attempted to be shown is perfectly essential to the formation of a stable and uniform pavement.

The *third* condition of Colonel M.'s plan is, that after a pavement has been once constructed according to the preceding rules, care should be taken to remove, from time to time, every protuberance occasioned by those inequalities of pressure to which all highways are liable; *and it is an essential feature in his plan, that this should be done by beating down the protuberances.* "The operation must not be too long delayed, for inequalities once formed, must necessarily increase with accelerated rapidity, inasmuch as the wheels continue to fall into the depressions with a momentum which progressively increases with the increase of the depressions."

In order to accomplish the more readily these three conditions of a good pavement, Colonel M. gives the design of a machine, which (being without a name) we shall take the liberty to call the "*flying stone-driver.*" The machine, as it is here described, appears susceptible of improvement; but there can be no doubt that, by something of the kind, the compression of the substratum, the ramming (as it were) of the blocks of stone (or wood), and the reduction of all protuberances as they occur, would be effected with great gain, both in point of labour and of dispatch.

The resulting advantages which the plan of Colonel Macerone appears to offer, are these:—

1st. That the whole of the present paving-stones might still be made available to the public service; not subjected to the pounding hammers of Mr. M'Adam, nor thrown aside to give place to the expensive masonry of Mr. Macnamara.

2nd. That the only new expense incurred would be the expense of taking up the present pavement, and re-laying it in a more solid manner.

3rd. That even that expense may in many instances be saved —in streets, for example, only recently paved, or of small thoroughfare—by a careful and continued application of the "Flying Stone-Driver."

4th. That the carriage-ways would thus, at a small expense, be kept constantly smooth and solid, and carriages roll easier over them, and with less noise.

5th. That the wear and tear of the pavement would be greatly diminished, less mud and dust occasioned, and the expenditure for repairs and cleaning proportionably reduced.

And 6th. That should the plan of paving with wood be found preferable to that with stone, and be adopted, either generally or partially, the system of management which Colonel M. proposes, would be equally applicable to both.

Another plan which claims a few words, and which, like the last, is of an intermediate kind, has been proposed by Mr. George Knight, in the *Quarterly Journal of Science*. Mr. Knight concurs in the opinion that the chief cause of the imperfections in the existing pavement is "the nature and state of the soil in which the paving stones are placed." He observes, with truth, "that while the present soil is continued as a substratum, so readily softened by water, and dug up loosely, as though to facilitate the stones driving into it at irregular depths, neither the triangular, the block, nor any other pavement, ancient or modern, will prevent its rapidly acquiring an uneven and muddy surface. Common earth and rubbish readily mix with water; thus mud must be formed under the pavement in wet weather, which, passing up through the needlessly-wide interstices, occasions a rapid accumulation of mud on the surface, and makes room for the descending stones," &c.

Mr. Knight agrees also in thinking that though the system of Mr. M'Adam is "preferable to any other yet introduced for a road not extremely used," it is wholly inapplicable to such great thoroughfares as the streets of London. "Such," says he, "is

the rapid wear by pulverization of granite, and all other brittle substances, and so slowly do they yield to mere friction, that I apprehend where the road would wear ten inches in a year, the well paved street would not yield more than one-fifth of an inch in the same period, after the first wear of the sharp edges of the stones, which with close joints would be very trifling."

Mr. KNIGHT's *remedy* is, to take up the present pavement, and then " to form a Macadamized road, on which, as soon as it had acquired, by raking and wear, an uniform and solid surface," he would, " without scraping it, lay paved stones of equal depth and width, and as square as they could be obtained consistent with economy," &c.

Either this plan or one similar to it, is alluded to by Colonel MACERONE (see *Hints to Paviors*, p. 23), as having been tried in Piccadilly, but found objectionable on several accounts. " According to this method," he says, " the old pavement is taken up for a space of about thirty or forty yards at a time, and a regular road is laid with gravel and broken granite, *à la M'Adam*, upon which the paving stones are subsequently laid, and the operation repeated for another forty yards. It, however, takes at least ten days or a fortnight to harden in succession, each of these tracts, sufficiently for the application of the paving stones; and these successive hardenings are to be performed by the carts, carriages, and horses, of the public, with so much inconvenience and annoyance as amounts to a complete nuisance. After all, this pavement of such troublesome and expensive production will not stand much longer than the old, and when any part of it is to be taken up, *how are we to restore that part to a hardness similar to the rest, without the powerful mechanical application proposed?*" So much has the force of all these objections been felt, that the plan has been since abandoned*.

Having now passed in review the various schemes that have been brought forward for the improvement of the pavement of the metropolis (as far as known to the writer), it only remains to

* *Note to the Second Edition.*—Not so, although it ought to have been. Fleet Street, Cheapside, Holborn, and several other parts of the Town have been paved in this way, with new stones, and vast quantities of gravel and broken granite, at an immense expense, but have been as villainously bad as soon as according to the old plan. But it is a better "Job" in the ratio of its far greater cost.

state the practical conclusions which seem to spring out of this inquiry.

It may be regarded, then, as abundantly established by experience, by the concurring opinions of nearly all who have investigated the subject, and by every common-sense view which can be taken of it—

I. That a good solid substratum is more than any thing else wanted to remedy the defects of the present system of paving.

And, II. That it is absolutely essential to have a superincumbent pavement formed of durable blocks of stone or wood, well packed together, and kept level by a vigilant system of superintendance.

The plans which combine, in the greatest degree, the performance of both these conditions of a good system of paving, are those of Mr. FINLAYSON and Colonel MACERONE, the latter more particularly; nor does there seem any reason to doubt that by one or other, or by an intermixture of the good qualities of both, the streets of the metropolis might ere long be so improved, as to leave little or nothing to desire. It depends on experiments yet to be made, and which it will take some time to make, whether it will be advisable to abandon the present practice of paving with stone; but should wood be found only to wear nearly as well as granite, the advantage which a wooden carriage-way would possess in occasioning less noise and less wear and tear of every kind, will doubtless cause timber blocks to be adopted wherever a new pavement is required to be laid down. But whether wooden blocks are ultimately adopted or not, or adopted only partially (as for instance in the more retired and fashionable streets and squares), the plan of Colonel MACERONE is of such a nature as to be applicable to any of these contingencies; it would suit equally well both stone and wooden carriage ways; and, whether it suited either sufficiently, a trial of a very few months would determine.

HINTS TO PAVIORS,

BY

COLONEL MACERONE.

HOWEVER true it may be, that an observant traveller is struck with admiration at the excellence of the turnpike and other roads throughout this country, he must, at the same time, be very much surprised at the badness of the *carriage pavement*, even of the principal streets of this astonishing metropolis. It is difficult for him to understand how, in a country where every mechanical art is best understood, and actually applied to the most useful purposes—where ingenuity, guided by science, is ever on the research for improvement—how, in the very capital of such a country, the carriage pavement should be, perhaps, worse than that of any other metropolis in Europe? It is, to be sure, justly boasted that this city enjoys the advantage of commodious and matchless foot-paths, and that the existence and goodness of such foot-paths are, in one point of view, of more general convenience and personal comfort than that of a perfectly level and easy carriage pavement, inasmuch as the safety and convenience of the thousands who walk*, should be preferred to that of the dozens who ride in their carriages. But, in a city like this, teeming with life and activity, throughout which so many thousand public conveyances perpetually travel at so rapid a rate, the state of the *carriage pavement* must surely be a matter of very great importance even to the walkers, who sometimes travel in *public* conveyances.

Previously to pointing out what I conceive to be the most advantageous method of improving the carriage pavement of London, I think it will be expedient to offer a few observations on the nature and construction of such

* It appears somewhat surprising, and anomalous, that, in this most aristocratic of all countries, so much attention should have been bestowed on the construction of foot-paths. In monarchical France, no such accommodation was ever thought necessary for the "*canaille*," who, consequently, are left to scramble out their way in the mud amongst the carriages, and under the hoofs of "their excellencies" horses.

Even at Smyrna, Bagdad, Aleppo, and Damascus, there are commodious foot-paths to a considerable distance beyond the suburbs!

pavements on the Continent as are most remarkable for their excellence and durability.

The ancient Roman paved roads, such as the Via Appia, the Sabina, the Flaminian, Emilian, &c. &c., first claim our attention. Of these, there are still tracts of many miles in perfect repair in Southern Italy, especially in the neighbourhood of Rome. A good foundation of gravel, broken limestone, or of basalt, was sometimes applied, where the nature of the soil required it. It is unnecessary to mention the causeways of solid masonry, over which they were at times carried, as such causeways, in certain situations, were as indispensable as they would be at the present day under the same circumstances of locality.

The stones composing the pavement of these roads are uniformly of basalt*, of a polyangular shape, containing, on an average, about four or five feet surface, and about twelve to eighteen inches in depth or thickness. They are generally more or less slightly pyramidical, and placed with the base or broadest surface uppermost†. It is by no means in every instance, as is asserted, that these stones are laid in a bed of mortar; in many situations I have found it to be otherwise‡. Neither are their edges chipped with any great nicety; the juxta-position is, however, well contrived, and indeed very remarkable; for although they vary *ad infinitum* in shape, angles, and more or less in size, they are fitted together as though each had been expressly cut for its situation.

It would appear, that in many places large tracts of these roads have been intentionally destroyed, either for the sake of the materials, or for the purposes of war and devastation; other portions have, in the lapse of ages, disappeared with the gradual changes to which the surface of this earth are subject, especially in inhabited districts, when barbarism rapidly succeeds civilization, or civilization barbarism. Such portions, however, as have been left to contend with the mere wear and use for which they were constructed some two thousand years ago, are in as good order and preservation as ever.

The pavements most similar in construction and solidity to the ancient Roman, are the modern Neapolitan. The stones of these are also of basalt, but in lieu of being polyangular, they are rectangular quadrangles, mostly squares, generally of about four feet surface, and six inches in thickness. The sides are very accurately wrought, as well as the surface, which is left as

* The preference for basalt was so decided, that where the roads, for instance, traverse the Appenines, composed of marble, and the hardest limestone, basalt has still been used, though it must have been conveyed thither at a great expense. In some instances, however, I have observed a single line of large marble, or limestone blocks, applied as an edging, or "curb," to the basalt. Basalt is volcanic lava: such as composes the Giant's Causeway; the lavas of Vesuvius and Etna; and Fingal's Cave, in the Isle of Staffa.

I am inclined to believe, that this exclusive use of basalt is attributable to its being, although harder, less slippery than marble or limestone. I have particularly remarked, in the town of Casserta, where some of the streets are paved with limestone, and the rest with basalt, that the former alone are most inconveniently and dangerously slippery, although both kinds of stone are cut and laid in a similar manner.

† I should, however, recommend the upper and lower surfaces to be equal.

‡ In most cases, no more mortar was used than was sufficient to fill up the interstices, which, from the shape of the stones, were rather wider below than at the surface.

rough as is consistent with a good level. These stones are laid in a thick bed of the best Puzzolana mortar, and always so arranged, that the lines of junction are never parallel with the line of road*, but cross it diagonally. This pavement excels in evenness and level, is very permanent, but expensive, and liable to become dangerously smooth, which renders it necessary, from time to time, to cut grooves on its surface. The city of Naples being admirably provided with sewers and sub-ways of the most solid construction, the necessity for disturbing the pavement very seldom occurs, so that the expense, though great, is pretty much confined to the first laying.

The pavement of modern Rome is also of basalt. The stones are parallelograms of about two cubes in length; and on being set up endways, they present about nine inches square surface. Although they are accurately cut, and equal in size, they are simply fashioned by a few skilful blows of the hammer. More mortar is used in the construction of these pavements, than even in the Neapolitan. I have observed the bed of the best Puzzolana mortar, on which they are laid, to be above a foot thick†. Rome being provided with the most extensive and complete sewers and sub-ways of any city in the world, its pavements, or, as they may be called, horizontal walls, have likewise very seldom any occasion to be disturbed‡.

The next kind of pavements that it may be necessary to mention, are those of Florence, of Sienna, of Milan, and some other cities of Northern Italy. These may, indeed, be assimilated to a kind of stone rail-road, as

* Opposite the Foundling Hospital may be seen a bit of expensive pavement, the stones of which are most accurately wrought and fitted together; but the lines of junction, being parallel to the line of road, deep furrows have been worn between the stones, in a few months after they were so carefully laid. Moreover, having no kind of *condensed* homogeneous foundation, it cannot be expected to retain its level, if subjected to the shocks of heavy carriages; in fact, they are already in a very dislocated state §.

† When the Roman or Neapolitan pavement is fresh laid, care is taken to cover it a foot deep with earth or rubbish, to protect the mortar, until it is set, from the jars of the carriages. The London paviers, who use no mortar, but lay their stones in loose gravel, nevertheless take especial care to imitate this practice, and carefully protect their loose stones and gravel (from the cold I suppose!) with a stratum of earth or rubbish, which speedily produces pools, of mud or clouds of dust. This is not merely ridiculous, but an abominable nuisance.

‡ At present there are in Rome but few streets which exhibit the ancient polyangular pavement. In most parts of the city it lays at the depth of from eight to twelve feet beneath the present surface. The accumulation over the whole extent of the Forum Trajanum, which was cleared away by the French in 1813, was, on an average, about twelve feet. That over the Forum Romanum, situated between the Mons Capitolanus and Mons Palatinus, was still greater.

I believe it will be found that the level of most cities has a tendency to gradual rise; as more materials are introduced into them than are ever taken out again. The numerous sackings, burnings, and subversions endured by Rome in the barbarous wars of the "good old times," those "dark ages," that ensued upon the introduction of the "light of Christianity," have produced a considerable rise in its level. This has necessarily been greater in the lower parts, between the celebrated Seven Hills, whose relative elevations have diminished proportionately. Thus the famed Tarpeian rock or precipice, on the south side of the Capitol, has, by the process of subtraction from the top, and addition to the bottom, during more than two thousand years, been reduced to less than forty feet in height.

§ *Note to Second Edition.* This is the pavement patented by Mr. MACNAMARA, alluded to by Mr. ROBERTSON, pages 5 and 6.

there are particular tracts allotted for the wheels, and others for the horses. The tracks for the wheels are composed of stones of very large dimensions; they are of marble, lumacular limestone, or of a very hard sand stone; most of them, particularly at Florence, weighing several tons. They are laid with much precision, in lines of about three feet broad. The spaces for the horses between these lines are paved with small stones, and are, as well as I can recollect, about four feet wide. In some of the squares, the small pavement predominates; while the lines of large stone-ways cross it in every necessary direction. Nothing can be more easy or agreeable than this pavement, which is suitable to carriages of every description, without the limitation or confinement of an iron rail-road, but with nearly the same smoothness*.

Among the causes which appear to me to have contributed to the extraordinary duration of the *ancient* Roman pavements, the geological nature of the surface over which they are constructed is not the least prominent. With the exception of the Pontine Marshes, and some tracts about Brindisi (Brundusium), Taranto, and Peruggia, nearly the whole of them have been carried over a surface of volcanic tuffo, of greatly compressed Puzzolana, or of calcareous or basaltic rock; all which furnish the best possible foundation. In countries where clay, gravel, or sand, are frequent at the surface, as in England, France, Alsace, part of Lombardy, &c., even these Roman pavements, when not kept in repair, have in time become impracticable for carriages.

The size and weight of the stones composing the ancient Roman pavements certainly do, *when once well laid on a compressed substratum*, oppose much *vis inertia* to the weights which roll over them, while their polyangular shape prevents any acute, or even right angles, being presented to partial pressure. This polyangular shape, and the excellent juxta-position of their sides, prevents any continuous line of junction being presented to the course of the wheels, which would so much tend to create ruts, and other irregularities.

It is necessary also to remark, that the carriages used in Italy, both anciently and at the present time, are what would be deemed in England very light. Besides which, the wheels of the modern Roman and Neapolitan carts are of a larger diameter than any used in England. It would appear that the carts of the ancient Romans were generally two-wheeled, drawn by two or four oxen. Travelling was, for the most part, performed on horseback, or in litters carried by two mules. Chariots for travelling do not appear to have been used at all, much before the close of the republic. They were both two and four-wheeled, but not made to carry more than two persons, besides the driver. They do not appear to have had any springs; the wheels were very low, and not more than thirty-two or thirty-three inches apart. So that, altogether, it may be presumed they were more calculated to bruise the bones of the riders, than injure the pavements over which they bounced.

* *Note to Second Edition.*—Where such a line of stones, which should be quadrangular prisms of granite or limestone, six, eight, or more feet long, and a foot square, laid along the common turnpike-roads, Steam Carriages, such as that recently patented by Mr. SQUIRE and myself, would travel, with ease, at twenty miles the hour; so that, in most cases, the vast outlay of railways would be quite unnecessary.

Such, in a very few words, are the best pavements I have had an opportunity of observing, and there is reason to believe there are no better existing. It does not, however, follow, because they are good, and perfectly well adapted to their respective purposes and localities, that any of them might be applied with advantage to the streets of London. I think it may be easily shown, that neither the ancient nor modern Roman, the Tuscan, or Neapolitan, would possess the qualities required for such an application.

To pave London after the ancient Roman plan, would, in the first place, be attended with enormous expense, and entirely new stones would be required for the whole undertaking. Stones of so large a surface would also become dangerous for horses, at a fast pace—or when drawing heavy weights—or upon an acclivity. In London, waggons and carts are in general use, of far greater burthen than any which were anciently or are at present used in Italy. Some of our stages and vans, to a very considerable weight, moreover, add great velocity. I shall be told, perhaps, that in proportion to this horizontal velocity, the vertical gravitation is diminished; but these carriages have very small fore-wheels, upon which the drivers, with extraordinary stupidity, contrive to place the greater part of the load*. Such small wheels, so over-loaded, descend with great violence into the least depression of the pavement, and are thrown up (to fall again) by the slightest protuberance.

I very much doubt whether, even in point of durability, either the modern Roman or Neapolitan pavements would succeed in London. Considering the friable nature of most descriptions of mortar, I suspect, that the repeated shocks of heavy carriages would pulverize and detach it from the inferior surface of the stones, part of it would work out, and the stones become loose†. A further great objection to any such solid masonry pavements is, the frequent necessity of partially taking it up, to lay gas and water pipes, and to repair our trumpery crumbling brick sewers‡.

The foregoing objections will equally apply to the modern Neapolitan pavements. The modern Roman has not the defect of being too smooth, but it has that of homogeneous chemical solidity, which will not admit of its being perpetually displaced for the temporary purposes above mentioned. Moreover, where are we to get a sufficient quantity of such Puzzolana mortar as is employed in Italy, with which the pavement becomes as one rock§?

With regard to the pavements, or, as I have ventured to call them, the stone railways of Florence, Sienna, Milan, &c. &c., the objections to their

* The pertinacity with which this custom is followed, is somewhat surprising in this scientific country. What are we to say to the riders too? We frequently see five or six in front on a stage coach, without a single person behind, or even inside!

† I have seen portions of ancient Roman road broken up by the passage of heavy artillery. A very few such large stones displaced, will render the road impassable for carriages.

‡ Our sewers are admirably planned and levelled; but the materials, and the construction, are very deficient of the necessary solidity.

§ I have frequently seen portions of such pavements undermined, and displaced by torrents, without a single stone being detached from the masses of several square yards surface, into which the pavement was broken. On one occasion, near Ancona, I remember the water having undermined the whole breadth of pavement, so as to admit of my crawling under it from one side to the other. I immediately after passed over it in my carriage, as safely as over a bridge.

adaptation to the streets of London must also be obvious enough. Independently of the enormous expense of the materials, such a system could never answer in streets where vehicles of all descriptions, going at every degree of velocity, have occasion to cross, pass, and run abreast of each other, over the entire breadth of the street. Such large stones, whether of granite or limestone, would soon become dangerously smooth for horses' feet, their longitudinal edges would wear, the contiguous stones sink, and ruts continually be formed along them, by wheels going in so many diagonal directions*.

It remains for me to observe a new method of paving, which has been lately attempted in Piccadilly, but which I am confident will not be found to possess any advantages over the old plan in general use, *at all commensurate to the great inconvenience and expense attending its formation.* According to this method, the old pavement is taken up for a space of about thirty or forty yards at a time, and a regular road is laid with gravel and broken granite, *à la M'Adam*, upon which the paving-stones are subsequently laid, and the operation repeated for another forty yards. It, however, takes, at least, ten days or a fortnight to harden in succession each of these tracts, sufficiently for the application of the paving-stones; and these successive hardenings are to be performed by the carts, carriages, and horses of the public, with so much inconvenience and annoyance as amounts to a complete nuisance. After all, this pavement, of such troublesome and *expensive* production, will not stand much longer than the old; and when any portion of it has to be taken up for pipe laying, &c., how is that portion to be restored to an equal density with the rest, without the powerful mechanical application I propose? In fact, there is no species of pavement that I have ever

* In that delectable imitation of the French, which is exhibited on the Hammersmith road, of which one portion is paved and the other not, the high ridge, which must perpetually exist at the edge of the paved portion, has afforded many good jobs to the surgeons, and wheelwrights †. *A propos* of French roads:—I will venture to digress so far as to observe, that, with the exception of their straightness, their construction, in other points, is very bad, indeed we may say, the worst in Europe. They are in general three times too wide; they are too much arched, or elevated in the middle, and when this part of them is paved, nothing is done to the lateral portions which are not. From being too wide, so much care cannot be bestowed on their construction, at the same expense as would suffice were they narrower. Secondly, the carriages and carts not being obliged to get out of each other's way (except on the crown of the pavement), form regular tracks, and ruts, for those going, and those coming, out of which they never dream of moving. These French carts and waggons are of quite as barbarous and rude a construction, as they could have been in the days of Clovis or Charlemagne, save and except, peradventure, that very ingenious invention of the modern French, for the express purpose of enabling the said carts to keep exactly, and undeviatingly, in the same ruts. For whereas, in different districts, the carts vary, more or less, in width, so that cart A would not be able to go exactly in the rut of cart B, it is contrived, that their axletrees should have six or seven inches to spare, over and above the portion confined in the nave of each wheel. The linch pin is affixed to the extremity of the axle, so that the wheels are at liberty to wash to and fro, from side to side, and adapt themselves exactly to the ruts, which the French road-makers so highly appreciate. In passing by a French cart you must, therefore, be careful to allow for, at least, six inches of concealed axle, which ever and anon darts out from the nave, like the tongue from the snout of a snake.

The middle portion of a French road, which is generally paved, is so much arched, that carts are naturally induced, if not compelled, to take the centre of it; so that those going in opposite directions use the same track, out of which they only momentarily move at the instant of meeting. Deep ruts are thus soon worn, even in the most substantial pavement—the

† *Note to Second Edition.* Since the above was written, this defect has been much diminished.

seen or heard of, to the application of which to the streets of London there would not be many great objections*. I, however, flatter myself, that, after much observation and reflection, *I have hit upon a method that would combine economy with durability, and with what is here quite indispensable, the admissibility of partially and frequently disturbing it, with no greater inconvenience or expense than occurs according to the present system.*

Having thus far, therefore, endeavoured to show, that solid cement-laid pavements, or even such as derive their solidity from the size and weight of the stones, would severally present many objections to their adaptation to the streets of London, I will now proceed to state what I conceive would prove a cheap and efficacious succedaneum.

MY EXPEDIENT IS MECHANICAL PRESSURE, WHICH MUST BE APPLIED IN THREE DIFFERENT STAGES OF THE WORK; FIRST, TO HARDEN THE GROUND PREVIOUS TO LAYING THE STONES; SECONDLY, TO FIX AND DEPRESS THEM WHEN LAID; THIRDLY, TO EQUALISE AND PERFECT A PAVEMENT AFTER IT HAS BEEN SOME TIME IN USE, BY APPLYING THE PRESSURE ONLY ON THE PROTUBERANT PARTS.

The machine I propose for the above purpose is similar to a pile-driver of the lesser kind; the weight being drawn up by a rope passing over a single pulley wheel at the top of the slide shafts, and terminating on the other side in a cluster of smaller ropes or cords, one for each of the six, eight, or ten men employed to work the machine. The weight, or "monkey," as I believe it is called, is raised by simultaneous hauls of the men, and let fall again by similar alternating movements of relaxation. For my purpose the weight should be of wood, more or less conical, with a flat circular or square base of about three feet diameter. A solid block of oak, well bound and shod with wrought iron, and weighing about 5 cwt., would produce sufficient force with very little raising; consequently with much rapidity, and be at the same time perfectly manageable. The perpendicular slide shafts and stays, together with the weight, that is to say, the whole of this simple machine, is to be fixed upon a

difficulty of repairing which, unless throughout the whole extent at once, must be sufficiently obvious. I have here alluded only to the two or three main roads of France. In the others, which they regard as secondary ones, I have travelled for scores of miles, where the ruts have been so deep, that on one of my wheels falling in, it could not touch the bottom, but rested on the nave and axle!

Besides the consequences of the defects of locality, and of materials, I have remarked three principal causes of the speedy deterioration of highways. Their being too wide—too much arched—and their having but little traffic upon them; all which circumstances conduce to the carriages keeping in one track, and to the consequent formation of ruts and holes. The only defect in the English high roads is, their having so many unnecessary, and often dangerous, turnings and windings. Here and there, they are even too narrow; and buildings have been suffered to encroach upon them.

* *Note to Second Edition.* A similar plan to the last noticed, has since been applied to Fleet Street, with the exception of the sublayers of gravel, and broken granite, not having been submitted to the action of horses and carriages, previously to laying the stones. Upon the stones being laid, a quantity of liquid mortar was poured over them, the wiseacre paviers not supposing that such mortar between the stones must be immediately reduced to powder so soon as dry. The pavement so laid in Fleet street was, at the end of a year, as bad as the worst in London. It is now being laid over again, on the same plan, but with new stones, with plenty of mortar *between* the stones, plenty of nuisance to the public, and plenty of expense. In one year's time it will, as will also the new Holborn pavement, be as bad as ever! But there is plenty of money, and plenty of people who like the "job!"

quadrangular frame of about eight feet by five; and to this frame I would attach four or six pivot or castor wheels of about a foot diameter, by which it might be moved with the greatest ease in every possible direction. If the men who work the weight are made to stand upon the frame itself, it may be worked uninterruptedly, while it is regularly drawn over the pavement, faster or slower, repeating or not repeating the blow on the same spot, according to the intention and discretion of the superintendent.

It surely must be allowed, that the present method of simply digging up the ground to a considerable depth with a pickaxe, without any subsequent hardening, can but furnish the stones with a foundation of very *unequal* resistance. It is true, that, after laying them in this soft bed, they are slightly compressed with a hand rammer; but it is obvious, that unless this compression be made equal to that which the stones will afterwards endure from carts, &c. the surface of the pavement must speedily give way, *and become the counterpart of the unequally dense substratum.* Even were the subjacent earth quite uniform in its density, or rather softness I should say, it is absurd to expect the pavement can preserve its level, when that density is so far from being sufficient to resist the maximum of pressure it is destined subsequently to endure. Were the subsequent pressure equally distributed, and applied to every stone, and were the subjacent density, or rather softness, also equal, then we might expect the whole surface to sink together; but as this can never be the case, as things *are* managed, inequality of pressure will speedily produce inequalities of the surface, which must increase in a rapid geometrical ratio. To establish a permanently level pavement with the materials we are speaking of, I do not say that the subjacent earth must be of a *perfectly* homogeneous density; it is sufficient that it be so compressed, both before and after laying the stones, that its parts of minimum density be able to resist the maximum of the pressure it will be subsequently liable to. In laying a new pavement, I should advise, first, to compress the earth with the machine, and afterwards repeat the ramming on the stones; by which division of the operation a degree of density would be obtained, with the application of much less power than would be required to produce the same by only one application on the surface of the pavement. If at this period the proper quantum of compression has been given, there is no fear of any inequalities being formed by the action of the heaviest vehicles; but I should not think it requisite to pave every street, there being many through which a vehicle heavier than a "gentleman's carriage" is seldom, if ever, known to pass*.

In cases where a street was been already paved in the old way, and when, as is usual in a few days, it has begun to assume its wonted picturesque unevenness of surface, it may be rendered perfectly and permanently level, without the expense of taking up the stones, by the careful application of the machine I recommend. But the operation must not be too long delayed; for inequalities once formed, must necessarily increase with accelerated rapidity, inasmuch as the wheels continue to fall into the depressions with a momen-

* In such streets, the very *ne plus ultra* would be the wooden pavement spoken of in page 9. Were the blocks of wood well saturated with coal tar, and driven down according to my plan, such a pavement would remain as level as a billiard table for twenty years.

tum which progressively increases with the increase of the depressions. An early obliteration of the nascent protuberances will put a stop to the evil, and a permanent density be established, as it will be increased, that is, improved, upon every application of the stone driver.

The exact state of the surface of the pavement is rendered remarkably evident and definable when water is thrown upon it; as I have had particular occasion to remark, when it has been applied abundantly to lay the dust. This I would make ancillary to the after-compressing operation I am now speaking of. The water-throwers should precede the machine, and certain men, with a good and careful eye, might mark the projecting stones with chalk, as a further guide to the action of the compressor. It is also probable that the water would, more or less, diminish the friction of the stones against each other, and facilitate their descent. I have frequently observed, that nearly one half of Piccadilly might be levelled in this manner, without the necessity of taking up a stone, except in a very few places, where extraordinary depressions have been formed. I do not, however, wish to establish the utility of the method I propose, on the merits of this second-hand application of it *alone*, but also upon its application under and upon the stones, at the time of laying them. *Nothing else will produce a level and permanent pavement with the materials at present in use, and consequently without increase of expense.* With regard to the improvement of these materials, it is certain that the more exactly the stones are cut, the better; it is essential to take off the convexity of the top or crown of the stones that are much worn. As to the size of the stones, I think the present ones about right. I should prefer them smaller, even as small as the Roman stones (p. 19). The London paviors are making them larger and larger every year, in order to induce the necessity for new ones. Any how, the stones should be equal in size at top and bottom;—that is, parallelograms. But let them be wrought with the most mathematical nicety, it will avail nothing in the end, if they are laid according to the soft, uncompressed method of the London paviors; or even on the thick layers of broken granite, and gravel above alluded to. If we would have an even pavement, we must either have recourse to the deep beds of cement, or the huge stones I have described in the beginning of this article, with all their expensiveness and other inconveniences; or we must apply to the method and materials already in use, the only process which will remedy their evident defects, and produce the wished-for result. As to the earth in which the stones are laid, I should prefer a mixture of broken gravel, dry rubbish, and a little chalk; but this arrangement also must depend on the expense. The quantity of oxide and carburet of iron which forms under the pavement, produces a strong tendency in the subjacent mass to indurate and agglomerate, which would be very greatly accelerated by the pressure I recommend*.

It now only remains for me to refer to the principal or only objection

* I have frequently had occasion to remark the very great degree of hardness which most earths will acquire, when submitted to pressure, after being saturated with animal or oleaginous fluids. *En passant*, I submit whether some such use might not be made of the blood of cattle from the slaughter-houses, and of broth from the huge cauldrons at Whitechapel, wherein many horses are boiled at a time for dogs'-meat.

which I can anticipate might be made to the use of my machine; which is, the supposed injury it might occasion to the gas and water pipes. It will be very easy to prove, in half an hour, by experiment, that no such injury can occur. Cast-iron pipes, at the depth of two feet, would not sustain any injury from the utmost efforts of the engine, especially if any care had been taken to lay the finer portion of the earth, or gravel, in immediate contact with them. But this precaution, I affirm, will be by no means necessary, if the pipes are from two to three feet from the surface, which surely is not an unreasonable depth.

I will fearlessly maintain, because I know I can prove, that by means of the foregoing method, a pavement can be formed with the present existing materials, without any increase of expense, which shall be more even and durable, than any other ever yet constructed. Such pavement will become better and better, the longer it is used; because, as each successive protuberance appears, and is beaten down, the whole will become more and more dense, and immovable. The "Commissioners," and the "Paving Boards," and the "Surveyors," and the paviors, and the granite mongers, and the contractors, &c. &c. may do their best (they have done their worst time out of mind); but, as adapted to the circumstances and localities of London, they will surely be compelled to adopt my plan, at least when "jobs" are at an end.

"Chi lava la test' all' asino, spreg' il sapone;
Chi predica al' deserto, perde il sermone."

To the French and to the Belgian paviors I also strongly recommend attention to the foregoing *exposé*. Their hundreds of leagues of paved high roads, may be rendered and maintained as even as a garden walk, and that without any increased expense. Then, and then only, will be made manifest, the superiority and economy of a paved road, over the best unpaved one, existing in Europe.

FRANCIS MACERONE.

MISCELLANEOUS HINTS,

INSERTED IN THE MECHANICS' MAGAZINE.

I have often thought how much it would contribute to the benefit of society, if any proportion of men of sense and observation were to publish all the various ideas of improvement which must frequently suggest themselves to minds of the least experience, or proneness to examination. The Mechanics' Magazine has proved itself an excellent vehicle for conveying such stray ideas to the public; so I flatter myself, that should any of the following series of hints, which I intend to publish, be deemed worthy the notice of any of your numerous readers, they will be honoured with their investigation and support.

The comforts and conveniences of life are made up of many things, which, taken singly, may appear of an unimportant and trifling nature; but as the Scotch say, "many littles make a mickle;" and he that adds but one pebble to the tumulus, does homage to the spirit to which it is raised. But I must not occupy your valuable pages with any further introduction to the trifles I venture to lay before you.

Increase of Day-light in London.

In a city built of red brick, where the immense consumption of coal overloads the atmosphere with smoke, and showers of soot, which speedily convert the ugly red into still worse hues of deeper gloom and black; where, in many parts devoted to important business, the streets being narrow, are still more smoky, black, and gloomy, just where light is most required; and in a climate too, where, except in very extraordinary seasons, we have but little familiarity with the rays of the sun;—that in such a city, in such a climate, and in the present age, the inhabitants should go on with their black light-absorbing walls, groping their way in the dark at mid-day, when a little lime and size is to be had for love or money, must surely be very surprising to any person who gives himself the trouble to think at all on the matter!

In every town in Spain, where a white wall would not be so much soiled in a thousand years, as in London in one month, every house is unnecessarily white-washed once a year. In Italy, many of the handsomest buildings are stuccoed and white-washed; and so are the entire cities of Naples, Faenza, Imola, Forli, &c.—But whether of stone or brick, every house is white outside; a red house seeming as fitting and picturesque to an Italian, as the stems of trees painted blue and red, in a cockney Dutch garden. In Spain and Italy they have plenty of light, without encouraging the reflection of it from the walls; but here, in London at least, there certainly is none to spare. Were every house white-washed once a year, or every two years, what a very great and beneficial increase of light would be produced!

I have heard it objected, that it is not classical, or regular, to white-wash brick walls. Is there, then, something so very architectural and classical in our lines of common brick houses, hideously black and filthy to boot? Let these objectors look at some new building constructed of white bricks,—let them observe most of the new churches, the Duke of Norfolk's house in St. James's Square, and several others of the same description, and then decide whether they do not look infinitely better, though not stuccoed, than if they were of the most flaming red, or even of the much admired British black! Talk of taste indeed! Who can witness with any patience, the stupid, tasteless, and expensive operation, called "pointing!" A huge apparatus of scaffolding erected for the purpose of painting a house red, and drawing delicate white lines around each brick!, very like the "taste" of our ancestors, who painted their bodies blue; and that of modern citizens, who so admire the sooty features of our public buildings, that they say, "it makes them look quite venerable." But I should think that, even in a ruin, there is no occasion for soot. A venerable old man or woman, clean and silvery, would not surely be improved by blackening them into a chimney sweep or cinder sifter! Look at that huge lump of coal, St. Paul's, see how all its beautiful architectural lines and proportions are confused, lost, or reversed, by the false shades of the "venerable" soot, laid on in regular irregularity, by the capricious pencil of the wind! Where there would have been a shade, is a white streak—where, on a prominent part, there would have been a light—it is completely black. The apparent size also of the building is very much diminished by being so black, which is well known to make all objects appear less. I would really recommend the gentlemen who so much admire black walls and columns, to convert to their doctrine the owners of the new buildings in the Regent's Park; but, above all, to gain over the pope and the Italians to their taste; by so doing, they may obtain an order for a sufficient quantity of the best Day and Martin's, to beautify St. Peter's, the Pantheon, the Cathedral of Milan, and all the other poor white edifices of Italy. Any how, if our houses and churches at home are to be black, it were better that they should be so uniformly and regularly; to effect which, what could be better than the said "Day and Martin's real japan!" But to conclude; seriously, I earnestly submit to the public the advantages which would result from giving to the whole of London, a clean, bright, and reflecting surface. Without white-washing, Regent Street will soon become as black as the Strand, or Cornhill, and with its whiteness, its most exhilarating feature will disappear. Imagine for a moment, that beautiful street to be constructed of sooty brick,—what a sad difference would it not produce! Nevertheless, there would still be some architecture, and good architecture in it, of which we have not a tittle to console us, in the sooty brick walls with holes in them for "windows," throughout the rest of London.

In order to perform that tasteful and microscopic operation, called "pointing," we see that a complete set up of scaffolding is required; but I opine that, to white-wash any house or edifice, no such trouble and expense would be required, as it might be done from boxes, moved up and down by pullies from the top.

White-wash, if properly made, with a due proportion of animal gelatine, (size) is impervious to water, and a great preservative to bricks, as well as to the soft lime-stones and sand-stones, of which most of the London edifices are constructed. The recently-renovated parts of Westminster Abbey are executed with soft Bath-stone, which decomposes and crumbles away, as soon as pure chalk. But the pretty lace-work carvings will last out the present generation, which is, I suppose, all the renovators have in view—except, perhaps, the legacy of another good job to their near descendants. As, however, it would be an outrage to certain tastes, merely to hint at white-washing Westminster Abbey, I think, I can show, in the succeeding article, that the cheese-like limestone of which it is constructed, may be rendered as durable as marble, by saturating it with whale, or any other oil, or the serum of the blood of animals.

A building might receive fifteen or twenty white-washings, before it would be necessary to scrape off the accumulated coats; so that a house white-washed every two years, would not require scraping for at least twenty or thirty years. With regard to the lines of a different shade, to represent or indicate the joinings of the stones or bricks, they may be drawn according to fancy, as we now see them in houses covered with Roman cement. The "pointing" fanciers also might still indulge in their miminy piminy performance around each brick, only in a white ground instead of a red. But should pure white be quite intolerable, any tinge of yellow may be obtained with a little ochre, to anticipate the darling smoke.

There is an Act of Parliament, which was brought forward by Mr. M. A. Taylor, to compel the owners of steam-engines, forges, breweries, &c. to construct their chimnies so as to consume the smoke. It was fully proved, that this can be effected with very little cost and trouble, yet not one of the thousands of huge volcano-like chimneys, which day and night vomit forth torrents of smoke, or rather soot, has been reformed "as the Act directs." According to our precious system, having no public prosecutor, "what is every body's business, is nobody's business;" and it is no agreeable business for an individual to bring an action against one of the soot makers, which might cost him £.500! Except it be in the cause of bigotry, stultification, and persecution, we seldom find our worthy countrymen associate and expend their money to enforce the enactments of the Honourable House, or to give effect to the Dodonian dicta of our venerable judges, called common law. To form any idea of the advantages which would result from the proper enforcement of Mr. M. A. Taylor's Act, it would be well to cast our eyes upwards in the neighbourhood of any great brewery, or take a boat at Battersea Bridge, and descend the river to Greenwich, in which trip we may behold seven hundred monstrous chimneys, each pouring forth enough soot to blacken seven hundred cities.

HINT THE SECOND.

Roman cement, when exposed to the action of the air and rain, absorbs water in such quantity, as to be penetrated quite through. Decomposition is assisted in the shade, by green mouldy vegetations, and still more mischief is done by the absorbed water expanding with the frost. Let any person

observe the side of a cement-covered house, after it has been exposed to the rain, they will find that it will take some days of fine weather to extract the water, and restore it to the same colour with the sheltered part.

We have numerous examples in nature, of animal gelatinous matter, forming in combination with aluminous, calcareous earths, and even siliceous sands, substances so hard and compact, as to strike fire with steel. In some lumacular lime-stones it is very easy to distinguish the parts which have received the *animal* matter of the shell-fish, from their superior hardness, and an agatized translucid appearance. I do not pretend that, by any artificial means, we can make agate or flint, but I have observed such a tendency to agglomerate and harden, in all earths that have been saturated with animal gelatine, or with oils, as I think might, in many cases, be turned to good account.

I would recommend all plastered walls to be washed over with linseed or whale oil, when at their greatest point of dryness, in fine weather. If size were to be added to the water in laying on the cement, its hardness and durability would be very much increased. Roman cement, mixed up with oil, without water, becomes as hard and compact as marble. But to lay it on in the usual way, and, when *perfectly dry*, to saturate it with oil, size, or serum, will be quite sufficient.

I have reason to believe that, in default of stone or bricks, artificial stones of sufficient solidity, might be substituted by applying animal gelatine, or oil, to earths submitted to strong pressure in cast-iron moulds. Chalk also, cut into regular shapes, and saturated with these substances, or with coal-tar, will become sufficiently hard to answer every purpose of building. If the latter fluid be used, it will moreover ensure that "venerable" sable hue treated of in the preceding hint. Any kind of mortar may be rendered very hard and durable by these means, and furnish an excellent arched coping for a wall.

It would be superfluous for me to do more than to hint at the various processes, by which what we call animal and vegetable matter, assumes other modes of gaseous, mineral, or fluid existence. With reference to the present subject, let any one contemplate the exposed side of a chalk hill, with the regular strata of flints between those of chalk; evidently the result of an accumulation, upon a consolidated bed of chalk, of gelatinous moluscæ, and other animals with which the ocean abounds, which were suddenly covered over by a new layer of cretaceous matter. Every body has seen agatized trees, some beautiful specimens of which are in the British Museum.

There is reason to believe, from analogy, that their silicification was promoted by their having been suddenly placed in certain circumstances, while their vegetable juices were entire and undecomposed, by which a particular kind of transmutation was produced, varying from the more general one which so amply provides us with fuel. The bones of animals, as well as shells, reduced to a fossil state, from the *phosphate*, are converted into *carbonate* of lime. Fowls feed entirely on oats, which contain much silicia, nevertheless produce plenty of lime to form their bones, egg-shells, and other calcareous secretions. Eggs have been found under the ruins of the palace of the Cæsars, on mount Palatine, completely converted into agate;

and a similar transmutation was found to have taken place in the interior of certain earthen pipes conducting from that palace to the Cloaca maxima, of which beautiful agate rings or bracelets have been constructed. In that curious specimen, a Guadaloupe negress imbedded in solidified sand, that portion of the mass nearest the bones is considerably harder and more compact than the rest, which is evidently occasioned by the greater quantity of animal matter it contains. Of an analogous but far more interesting description, is the beautiful cast from the bust of a young woman, preserved in the museum at Naples. In the eruption of Mount Vesuvius, when Pliny the elder lost his life, the towns of Herculaneum and Pompeii were overwhelmed by a flood of water from the Volcano, mixed with a prodigious quantity of pumice stone, and other volcanic matter, for the greater part as fine as sand, which found its way into the cellars, and unluckily even into the amphoræ of wine*, which, according to the present custom in Italy, was protected from the air by a little oil on the top. As might be expected, from the nature of the materials, the minutest portions of the alluvia found their way to the bottom, and in this mass of pumice sand, if I may so call it, and detritus of scoriæ, a young woman, apparently flying from the danger, was overwhelmed, and her skeleton was found, in 1792, laying on its face, with a bunch of keys in the right hand. The mass of aluminous and silicious particles immediately under her, becoming saturated with the humours of her decomposing body, became as hard as limestone; and had the discovery been made by any other than the ignorant peasants at that time employed, and who broke every thing to pieces in search of gold and trinkets, there is little doubt but a complete mould of her entire body might have been obtained. As it was, nothing but the bust from the chin to the waist was preserved—and a most beautiful bust it is—not quite so much developed, but quite as perfect as that of the Venus di Medici. The impression of a thin shift, or tunic, I suppose I must call it, with the hem across the lower part of the breasts, is perfectly impressed, and, if I remember right, part of the tissue itself adheres to the mould, from which a plaster cast has been taken, and placed beside it.

In a public walk at Naples, the ground of which is principally composed of broken tuffa, containing alumine and silex, a few drops of oil have occasionally fallen from the lamps, or been spilt by the lamp-lighters. This small quantity of oil occasioned so great an induration, and the garden being regularly swept, in process of time, little hemispherical hillocks were formed under each lamp, of such consistency as to resist the spade and pickaxe. Some of them two feet diameter, and quite hard enough for building, I saw taken out, like corns as it were, by digging around and under them.

About a year ago I poured a quantity of coal tar upon a heap of road scrapings, which, when removed six months after, was much harder than a mass of solid chalk. A walk made of gravel and road scrapings, to which I also applied coal tar, became as hard as a rock, and quite impenetrable to water.

In No. 161 of the *Mechanics' Magazine*, I have presumed to offer some observations on the excellent lectures of Mr. William Allan, at Guy's Hospital, in which he so well and philosophically alludes to the incessant and universal transmutations of matter. I will venture to hope that the foregoing little

* Large earthenware bottles, containing about five gallons.

remarks of mine may, by your indulgent readers, be taken for humble and familiar illustrations of *some* of the facts Mr. Allan adverts to.

What treasures of useful knowledge would rapidly be brought forth to improve the moral and physical condition of mankind, were not those on whose education most time and money are expended, chained down for years, almost exclusively to the parrot-like acquirement of mere words and sounds, in which any "learned doctor" would be beaten hollow by a resuscitated Roman or Greek infant of seven years old! The polish and the ornaments are mistaken for the foundation of the structure itself. Your collegian will for years bewilder his poor head with abstract qualities, without any substance to support them—as whiteness without a white body—motion without matter, which is its essence!

Happily for mankind, although the present generation still behold the bewigged and belawned buffoons of universities and colleges enacting discussions on the nature of the light of mount Tabor, on the accent of a Greek word, and stultifying themselves and hearers with insane *metaphysical* jargon —thanks to Mechanics' magazines, Mechanics' institutions, and lectures, the more worthy and useful members of the community are beginning to study things of real existence and utility; and are learning the best possible means of benefiting themselves, by contributing to the felicity of their fellow-creatures. Thus will they soon discover the fundamental principles upon which the improvement and happiness of society depend. For instead of reasoning on phantoms, reality is beginning to be the basis of their inquiry; and the mind, resting on that solid foundation, may accumulate an extent of science, of which, at present, we can form no idea. Sentiments of the noblest delight must accompany every addition to such knowledge—knowledge of realities and facts, which can only be obtained by the free, unrestrained operations of thought, with no other guides than FACTS and EXPERIENCE.

I fear I shall be accused of extending this article to an unreasonable length, of travelling far "out of record," as the lawyers have it, and of giving "great cry but little wool." I began by recommending houses to be white-washed, and daubed with oil or size, and I now find myself talking about Mounts Vesuvius and Palatine, the Venus di Medici, ladies' *tunics*, feeding hens, gravel walks, and Mount Tabor!—However, it may be my luck, for some kind of people to find a matter or so of utility in these hasty ideas, although so clumsily put together. Should such be the case with any of your readers, I flatter myself that, having the necessary leisure, they will condescend to examine into their correctness and utility, and, finding them worthy of it, give them notice and support.

HINT THE THIRD.

Among the minor exhibitions of the inherent functions of matter, which concern us in a domestic or economical point of view, is the oxidation of iron. To treat chemically or geologically on that important modus, oxygen, is not my present purpose; although it will be necessary for me to point out a few simple *facts*, on which to establish the humble hints which I venture to submit to the consideration of your readers.

The great increase in bulk produced in iron, particularly wrought iron, by

its combination with oxygen, would be familiar to most people, and superfluous for me to indicate, were there not so few amongst the multitude, of whom it might not be said, " they have eyes, and see not—they have ears, yet do not hear." It is certain, however, that the more minute, and what are called trivial, because familiar functions of matter, are equally important, inherent, and characteristic, as the most extended and comprehensive. The habitual contemplation of the former, is highly calculated to advance us in the knowledge of the latter, which are only analogous repetitions or combinations of the same immutable qualities, on a larger scale of concomitant modes of action. To speak as much as possible *sans prétention*, and on a level with the subject of rusty pipes and screws, I will only venture on a few illustrations from the most simple actions of life, begging my reader to remember, that there is, or ought to be, " reason in roasting eggs."

A man, for instance, will look up with superstitious admiration at the clouds; but observe not the condensation of his breath, on entering his cellar for a bottle of wine. He is awe-struck at the thunder; but draws his cork with a pop, and thinks of nothing but the contents of the bottle. He sees the bits of cork attracting each other, according to their masses, on the surface of his potation; but sees nothing like it in the general laws of attraction. He declares the lightning to be a *singular* and awful phenomenon; while he makes no reflections on the sparks which he draws from the back of his cat, and much less to those which he can elicit at pleasure from his own eyeballs. He might observe, that every portion of matter, when sufficiently at liberty—every drop of rain, or dew, or mercury—every air or soap bubble, assumes a globular shape; while he ascribes the shape of this earth, and of other spheres, to imaginary causes, totally foreign to matter's immutable properties. He attributes the circulation of his blood to extrinsic and capricious " *design*;" but heeds not the analogous circulation of the waters of the earth, through river, cloud, and ocean. He marvels at the combination which constitutes his own, and some other organized identities; but swallows his salt, or shakes the snow off his garment, without perceiving the equally necessary and inherent shapes which that mode of matter assumes on crystallization. He manures his garden, and feeds his cabbages with the remains of other cabbages; but, notwithstanding Mr. Allan's lectures, and the evidence of his senses, he sees not that he himself bears a similar relation to all that precedes, surrounds, and succeeds him. He is not surprised to see an ant-hill swept away by a shower of rain; but if he hears of a city or a province overwhelmed by a flood, he ascribes it to some fanciful and ridiculous cause. He sees the glands and tissues of his body secrete humours which solidify upon their union with oxygen, and, that as he grows older, his body becomes more and more rigid, exsiccated, and dense; but he perceives nothing analogous to this process, in the operations of volcanoes and zoophytes, and the gradual diminution of the waters of the globe. But whither, in the name of patience, am I wandering? Pray, gentle reader, show me the way to the Bank of England, for it was thereabouts that I had proposed to myself to look for the first little fact concerning iron-rust, or oxidation as they call it.

So, then, I was going to say, that such persons as made use of their eyes while passing the Bank, previous to the erection of the new façades, must have observed that every one of the columns which surround it, was more or

less broken or displaced, by the oxidation of the horizontal bars of the railing, each end of which was fixed under the pedestal of a column. Again, most persons who frequent that part of the town, must have seen that Bow Church steeple was lately obliged to be taken down, and rebuilt; and they might have heard, that it was on account of certain iron cramps having so greatly dilated, through rust, as to lift up the entire fabric out of its perpendicular. I have seen the iron bars of a window exposed to the sea-air, and occasionally to the spray, dilate to twice their original diameter, and split, from top to bottom, blocks of marble and basalt, eighteen inches cube, in which they were inserted. I have seen an anchor, inserted about ten feet below the summit of a pier, lift up and displace the superincumbent masonry of huge stones. And finally, to return home again, let any one examine the wrought iron railing in the older streets of London, and he will observe most striking instances of the process I am speaking of.

No species of oxidation of iron is so complete, or so rapid, as that which occurs to it when buried in the earth. And it appears also to be greatest, when placed at from three to twenty feet below the surface, and *in a gravelly soil.* In such situations, a kind of assimilating agglomeration of the surrounding gravel takes place, by which the metal is again converted into ponderous ore, radiating in spicular arrangement from the centre outwards. In compact clay, I have observed the oxidation to be of a slower and different kind—a mere exfoliation, less considerable than what occurs in the common atmosphere. Owing to the great quantity of carbon (soot) deposited on the streets of London, when iron pipes are only a few inches from the surface, oxidation is often checked by the formation of carburet of iron; as I have already remarked in my little work, called *Hints to Paviors.*

In 1808, I found, near Capua, an antique sword, supposed to be Carthagenian, the blade of which had formed a hard tenacious agglomeration, with concentric radiations, thicker than my arm, and weighing seventeen pounds, which I am inclined to think would, upon analysis, have yielded much more iron than had ever entered into its original composition. Amidst the pumice stone and puzzolana which cover Pompeii, large fragments of doors, &c. are occasionally found, with parts of hinges, locks, and nails. The iron has prodigiously diffused itself, and agglomerated the surrounding earths, as well as penetrated the contiguous wood, which, in some cases, I have seen beautifully mineralized, while still preserving its ligneous appearance.

The upper stratum, in and about London, is chiefly gravel, consequently, as I have observed, the most liable to oxidize the innumerable gas and water pipes with which it is intersected. I have paid some attention to the state of these pipes, after different periods of interment; and I feel convinced, that it would be much to the interest of the parties *who pay for them*, were some means adopted to counteract the rapid deterioration they undergo.

Corporate bodies are not famed for economy; the interest of the managing parties being often, if not generally, at variance with that of the shareholders; and it is in the nature of things, as recent exposures have woefully demonstrated, that to *direct* the expenditure of one's own money, and that of other people, are very different things. Such among the labourers employed in laying down the pipes as I have happened to interrogate, have seemed to think that the pipes might be made to last much longer than would be con-

sistent with *their* interest, or with that of the iron founders; and in other cases, we see such a continual chopping and changing of the pipes, either from changes in the water, and gas companies, or from not having laid down sufficiently large ones in the first instance, as to put the oxidation I speak of out of the question. There must, however, be many cases, in which the pipes are destined to remain a long time undisturbed, particularly, I should suppose, in what they call "the mains," some of which I have seen thirty inches in diameter.

To counteract the oxidation of iron pipes, I should propose to coat them outside with some substance impermeable to, and not easily decomposed by, water. The best and most economical substance I have been able to devise, is made with two parts of coal tar, and one of lime, in powder. It should be applied to the pipes before they are brought out to be laid; and to do it properly, they should be warmed, and suspended by a pole put through them.

Another effectual method of preventing oxidation is, to apply to the pipes while hot, a coating of sulphur, either pure, or with the addition of one-third part of lime. This will produce on the surface of the pipes a strong crust of sulphuret of iron, which will effectually intercept the access of oxygen. It is needless to observe, the inside of the pipes require no protection.

It would be well if, instead of lead, with which the junctions of the pipes are at present sealed, some kind of hard mastic were substituted. Any how, the lead, or rather that part of the iron in junction with it, should be particularly guarded from the rust; seeing that the galvanic action of the two metals must greatly promote the decomposition of the water which gets between them; and the accumulation of oxide in that situation, would inevitably burst the exterior pipe. In my merely fortuitous observations, I have seen this happen several times.

I have yet to point out a case of far more importance than the preservation of water-pipes; the consumption of which is, after all, according to my Irish friends above alluded to, "good for trade," at the expense only of a tithe out of the great profits of the companies. The case I allude to, is, the rapid deterioration of the Southwark Bridge. This beautiful and stupendous structure, with an arch of 240 feet span, to behold which, several eminent foreign engineers have come purposely to this country, is suffering such decay, from mere oxidation, as could never be imagined but for minute observation. With the exception of the balustrade, and exterior lateral members, which had *one* coat of paint, no kind of preservative, paint or tar, has ever been applied to it!

Cast iron is certainly not so liable to oxidize as wrought iron; *but it must be remembered, that the parts of a cast iron bridge are held together by wrought iron bolts, screws, and nuts.* The oxidation which takes place between the nuts and the cast iron members, will, at length, force the former from off the end of the bolts, just as I have seen it occur to gun carriages on a sea battery.

About two months ago, I witnessed a very remarkable proof of the shameful state of the bridge we are speaking of. As I approached the centre arch in a boat, my attention was much excited by what seemed to be a thick shower of dead leaves, or pieces of brown paper, just as if they had proceeded from several baskets full, thrown over from the top. Upon